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DESCRIPTION

PRINTED CIRCUIT BOARD, A PRINTED CIRCUIT  
ASSEMBLY AND ELECTRONIC APPARATUS

5 TECHNICAL FIELD

The present invention relates to printed  
circuit boards having external connection terminals,  
a printed circuit assembly in which electronic  
components are mounted upon such a printed circuit  
10 board, and an electronic apparatus in which foregoing  
package is connected to form a circuit such as a  
protection circuit, or the like.

BACKGROUND ART

15 In recent years, significant advancements  
have been made in reduction of size and weight in  
electronic apparatuses. This trend of size reduction  
and weight reduction is particularly remarkable in  
portable apparatuses such as cellular phones. In  
20 relation to this, there is a demand for size  
reduction of printed circuit boards carrying various  
electronic components such as semiconductor devices  
and passive components.

In relation to the foregoing trend of  
25 technology, there is a demand for a built-in charging

control circuit used with portable devices for  
controlling charging of secondary battery pack, such  
that the charging control circuit is integrated into  
the secondary battery pack. Thus, especially severe  
5 demand of size reduction is imposed on such a  
charging control circuit of secondary battery pack.

Meanwhile, electrical connection between  
the electrode of a secondary battery and a charging  
control circuit is achieved usually by using an  
10 interconnection lead of a nickel plate in the case  
the secondary battery is accommodated in the battery  
pack, in view of the fact that a nickel plate is used  
for the interconnection pattern taking out the  
electric power from the electrode with the secondary  
15 battery accommodated in a battery pack. By using such  
a nickel plate for the interconnection pattern, it  
becomes possible to connect the interconnection  
pattern to the electrode simply and directly by way  
of spot welding. Further, by using such a nickel  
20 plate, it becomes possible to eliminate the need of  
providing additional interconnection patterns for  
electrical interconnection between the secondary  
battery and the charging control circuit. Thereby,  
the size of the charging control circuit can be  
25 reduced further.

On the other hand, the use of such a nickel plate for the interconnection between the secondary battery and the charging control circuit imposes a demand to such a battery pack in that the external  
5 terminal of the printed circuit board carrying the charging control circuit should allow spot welding of nickel plate.

In order to meet for this demand, the external interconnection terminal of the printed  
10 circuit board used with such a secondary battery pack has been formed by forming a land on the surface of a base substrate of the printed circuit board in the form of a metal foil and by soldering a nickel plate on such a land.

15 For example, there is an external interconnection terminal as set forth in Patent Reference 1 in which a nickel plate is soldered upon a land formed on the surface of a printed circuit board via solder resist patterns formed so as to  
20 divide the land surface evenly. With such a construction, the tensile force acting upon the nickel plate with melting of solder is cancelled out by the tensile forces caused in the respective divided portions of the land. Thereby, precision of  
25 alignment of the nickel plate on the printed circuit

board is improved together with the mechanical strength.

Further, there is proposed another construction as set forth in Patent Reference 2, in which a nickel plate having a U-shaped cutout or hole is soldered upon the surface of a printed circuit board. With such a construction, total length of solder filet formed at the time of soldering is increased, and mechanical strength of contact is improved at the same time.

Further, Patent Reference 3 discloses a construction of interconnection terminal formed on a printed circuit board, in which a metal plate is soldered upon a land formed on the printed circuit board for external connection, wherein a solder resist layer is formed between the land and the part of the metal plate on which an external lead wire is to be soldered. With such a construction, melting of the solder provided between the metal plate and the land is avoided at the time of soldering a lead wire to the metal plate, and drifting of the metal plate away from the land is prevented.

Thus, with this reference, the lead wire is soldered on the foregoing part of the metal plate in which the solder resist exists between the metal

plate and the land. By soldering the lead wire to such a part of the metal plate not soldered directly to the land, it becomes possible to prevent the melting of the solder layer connecting the metal plate to the land. Thereby, the problem of displacement of the metal plate with regard to the land during the soldering work of the lead wire as a result of melting of the solder between the is successfully prevented.

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#### REFERENCES

Patent Reference 1 Japanese Laid-Open Patent Application 2002-100412 official gazette

Patent Reference 2 Japanese Laid-Open Patent Application 2002-111170 official gazette

Patent Reference 3 Japanese Laid-Open Patent Application 10-321981 official gazette

#### DISCLOSURE OF THE INVENTION

20 While the external interconnection terminals of foregoing references of soldering a metal plate upon a land have been devised for increasing the mechanical strength of the external interconnection terminal, such prior art merely  
25 anticipate for soldering of a lead wire, or the like,

upon such an external interconnection terminal, and do not anticipate interconnection of a metal plate by way of spot welding.

When a metal plate soldered upon such a  
5 land has been pulled by force as in the case of spot welding, there can appear one of the following two states: the first being the state in which peeling destruction occurs at the solder layer connecting the metal plate to the land; and the second being the  
10 state in which peeling destruction occurs at the land such that the land is pulled apart from the printed circuit board while carrying the metal plate soldered thereon.

The former situation occurs in the case  
15 pores are formed between the metal plate and the land at the time the metal plate is placed on the land and the pores thus formed have remained even after the solder paste provided between the land and the metal plate has caused reflowing. In such a case, the  
20 effective area of soldering becomes insufficient and hence insufficient mechanical strength for the solder layer. On the other hand, the latter situation occurs in the case the contact area between the land and the printed circuit board is reduced as a result of size  
25 reduction of the land.

Thus, a first object of the present invention is to provide a printed circuit board having an increased mechanical strength for the external interconnection terminal thereof particularly for the part between the land and the printed circuit board, such that the external interconnection terminal can bear the stress at the time of connecting another metal plate to the external interconnection terminal by way of spot welding, without causing peeling of the land from the printed circuit board.

A second object of the present invention is to provide a printed circuit assembly in which electronic components are mounted on such a printed circuit board.

A third object of the present invention is to provide an electronic apparatus having such a printed circuit assembly.

Thus, the printed circuit board of the present invention has an external interconnection terminal on the surface of a base substrate in the form of a metal plate soldered upon a land formed on such a base substrate by a metal foil.

In a first aspect of the present invention, there is provided a through-hole in the printed

circuit board penetrating through the land and a base substrate of the printed circuit board, such that the penetrating-hole is filled with a solder alloy continuously to the solder layer connecting the land  
5 and the metal plate.

Preferably, there is formed a second land at the rear surface of the printed circuit board so as to oppose the first-mentioned land across the base substrate of the printed circuit board, such that the  
10 second land at the rear surface is connected to the first-mentioned land at the front surface via the through-hole.

Such a through-hole can be provided in plural numbers in each land. Thereby, the number and  
15 arrangement of the through-holes can be determined according to the size of the land and the force exerted upon the external interconnection terminal at the time of the spot welding.

Further, it is preferable to form a solder  
20 resist on such a printed circuit board so as to cover continuously from the peripheral edge part of the land formed on the surface of the base substrate to the part of the base substrate surrounding the land.

Further, it is possible to form the solder  
25 resist layer on a part of the land surface formed at



the front surface of the base substrate.

Thereby, it is preferable that the solder resist layer thus formed on the land is formed so as to divide the region in which the land is soldered to the metal plate into plural sub-regions. Further, it is preferable that such a solder resist layer extends to the outside of the land across the land peripheral edge.

Further, it is preferable that the solder resist layer at the peripheral edge part of the land and the solder resist layer inside the land form a structure dividing the region of the land, in which the land is soldered to the metal plate, into plural sub-regions.

According to a second aspect of the present invention, the printed circuit board is not provided with the through-hole, and there is provided a solder resist layer to extend continuously from the peripheral edge part of the land on the base substrate to the region of the base substrate surrounding the land.

In this case, too, it is possible to form a solder resist layer in a part of the land surface at the front surface of the base substrate.

In this case, it is preferable that the

solder resist layer formed inside the land divides the region of the land soldered to the metal plate into plural sub-regions.

Further, it is preferable that the solder  
5 resist layer at the peripheral part of the land surface and the solder resist layer inside the land form a structure dividing the region of the land soldered to the metal plate into sub-regions.

Preferably, the solder resist layer used  
10 with the present invention is identical to the solder resist layer used for protecting the interconnection patterns on the base substrate.

It is preferable that the metal plate  
soldered to the land at the external interconnection  
15 terminal has an area larger than the area of the land and disposed such that the metal plate covers the land over the entirety thereof.

Further, the printed substrate assembly of the present invention comprises the printed circuit  
20 board as noted above and the electronic components carried thereon.

Further, the electronic apparatus of the present invention comprises the printed circuit assembly as set forth above and an electronic device  
25 connected to the printed circuit assembly via an

interconnection metal plate such that the interconnection metal plate is connected to the metal plate of the external interconnection terminal of the printed circuit board by spot welding.

5               In an example, the interconnection metal plate and the metal plate of the external interconnection terminal of the printed circuit board comprises a plate of nickel or nickel alloy.

              An example of such an electronic apparatus  
10 is a secondary battery pack in which a secondary battery and a charging control circuit thereof are integrated. In such secondary battery pack, the secondary battery constitutes the electronic device to be connected, while the charging control circuit  
15 of the secondary battery constitutes the printed circuit substrate assembly in the form of a semiconductor integrated circuit mounted on the printed circuit substrate as the electronic component.

20               According to the printed circuit substrate of the first aspect of the present invention, in which there is formed a through-hole in the external interconnection terminal so as to penetrate through the land and further through the base substrate and  
25 in which the through-hole is filled with a solder

alloy continuing to the solder layer connecting the land and the metal plate with each other, there is formed a structure in which the land is connected mechanically to the base substrate with the solder alloy, and the mechanical strength of the land for resisting from being peeled off from the base substrate is increased. Thereby, dropping of the external interconnection terminal from the printed circuit board is prevented effectively even in the case a large force is exerted to the metal plate soldered upon the land.

Further, with such a construction, the heat at the time of spot welding dissipates efficiently to the substrate via the through-hole, and the problem of the molten solder alloy causing scattering is prevented.

Further, by forming a second land at the rear side of the base substrate so as to oppose the first-mentioned land at the front surface of the base substrate and by connecting the land at the front surface with the land at the rear surface by the solder in the through-hole, there appears the structure in which the land at the front surface and the land at the rear surface are mechanically connected, and the resistance of the land from being

peeled off and dropping from the printed circuit board is improved further with such a structure of sandwiching the base substrate of the printed circuit board by the first and second lands.

5               Further, by forming the solder resist layer so as to cover continuously the peripheral part of the land surface and the part of the base substrate surrounding the land, the peripheral edge of the land is held by the solder resist film, and the resistance  
10 of the land from being peeled off from the printed circuit substrate is improved further. Further, such a solder resist layer at the peripheral edge of the land can successfully prevent the problem of scattering of the molten solder alloy at the time of  
15 spot welding.

              Further, by forming a solder resist layer in a part of the land surface, such a solder resist layer can be used to prevent scattering of the molten solder at the time of the spot welding made to the  
20 metal plate.

              By providing the solder resist layer on the land such that the solder resist layer extends to the outside of the land, or by providing the solder resist layer at the peripheral part of the land and  
25 inside the land, such that the region of the land

soldered to the metal plate is divided into plural regions, formation of pores between the land and the metal plate at the time of soldering the metal plate is suppressed, and it becomes possible to increase  
5 the effective area for soldering. Thereby, the mechanical strength of the structure of the metal plate and the land is improved.

Further, by forming the solder resist layer so as to extend continuously from the peripheral edge  
10 part of the land to the part of the base substrate surrounding the land also in the printed circuit board not formed with the through hole penetrating the land and the base substrate, the peripheral edge of the land is held by the solder resist layer thus  
15 formed so as to cover the peripheral edge part of the land and the part of the base substrate surrounding the land continuously, and the resistance of the land from being pulled off from the printed circuit board is increased. Further, the solder resist layer  
20 covering the peripheral edge part of the land surface functions also to prevent scattering of the molten solder at the time of spot welding.

In such a case, too, by forming a solder resist layer in a part inside the land, scattering of  
25 molten solder alloy at the time of the spot welding

can be prevented with such a solder resist layer.  
Further, by dividing the soldering region between the  
land and the metal plate by the solder resist layer  
at the peripheral edge part of the land and the  
5 surrounding region, formation of pores between the  
land and the metal plate at the time of soldering of  
the metal plate is suppressed, and it becomes  
possible to increase the effective area of soldering.  
Thereby, the resistance of the metal plate and the  
10 land from being peeled off is improved.

Further, by using a solder used also for  
protecting the interconnection patterns on the base  
substrate for the solder resist layer, it is possible  
to avoid increase of the number of the process steps.

15 By increasing the area of the metal plate  
to be larger than the area of the land soldered  
thereto, and by disposing the metal plate such that  
the entirety of the land is covered with the metal  
plate, it becomes easier to connect another metal  
20 plate thereto.

Further, by forming a printed circuit  
assembly by mounting an electronic component on such  
a printed circuit board and by connecting a metal  
plate of an electronic apparatus with the metal plate  
25 of the external interconnection terminal of the

printed circuit board by spot welding,  
interconnection to the electronic apparatus such as a  
battery in which the electronic plate is spot-welded  
as an electrode is achieved easily.

5               Further, by using a nickel plate or nickel  
alloy plate for the metal plates connected with each  
other, spot welding can be achieved easily. Further,  
the metal plate of nickel or nickel alloy does not  
cause corrosion easily.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1A is a plan view diagram showing a  
printed circuit board according to an embodiment of  
the present invention in the state of carrying an  
15   electronic component thereon while Figure 1B is a  
cross-sectional diagram taken along an A-A line in  
Figure 1A;

Figure 2 is a diagram showing the printed  
circuit board of the embodiment of Figures 1A and 1B  
20   in the state a metal plate is soldered upon an  
external interconnection terminal thereof;

Figure 3A is a plan view diagram showing a  
printed circuit board according to another embodiment  
of the present invention in the state of carrying an  
25   electronic component thereon while Figure 3B is a



cross-sectional diagram taken along an A-A line in  
Figure 3A;

Figure 4 is a diagram showing the printed  
circuit board of the embodiment of Figures 3A and 3B  
5 in the state a metal plate is soldered upon an  
external interconnection terminal thereof;

Figure 5 is a plan view diagram showing the  
external interconnection terminal of the printed  
circuit board according to a further embodiment of  
10 the present invention;

Figure 6 is a plan view diagram showing the  
external interconnection terminal of the printed  
circuit board according to a further embodiment of  
the present invention;

15 Figure 7 is a plan view diagram showing the  
external interconnection terminal of the printed  
circuit board according to a further embodiment of  
the present invention;

Figure 8 is a plan view diagram showing the  
20 external interconnection terminal of the printed  
circuit board according to a further embodiment of  
the present invention;

Figure 9A is a plan view diagram showing a  
printed circuit board according to a further  
25 embodiment of the present invention in the state of

carrying an electronic component thereon while Figure 9B is a cross-sectional diagram taken along an A-A line in Figure 9A;

Figure 10A is a plan view diagram showing a  
5 printed circuit board according to a further  
embodiment of the present invention in the state of  
soldering a metal plate on the external  
interconnection terminal thereof while Figure 10B is  
a cross-sectional diagram taken along an A-A line in  
10 Figure 10A;

Figure 11A is a plan view diagram showing a  
printed circuit board according to a further  
embodiment of the present invention in the state of  
carrying an electronic component thereon while Figure  
15 11B is a cross-sectional diagram taken along an A-A  
line in Figure 11A;

Figure 12A is a plan view diagram showing  
the printed circuit board according to a further  
embodiment of the present invention in which a second  
20 metal plate is spot-welded upon the external  
interconnection terminal thereof while Figure 12B is  
a cross-sectional diagram taken along an A-A line in  
Figure 12A;

Figure 13 is a cross-sectional diagram  
25 showing an electronic apparatus according to a

further embodiment of the present invention.

BEST MODE FOR IMPLEMENTING THE INVENTION

Hereinafter, the present invention will be  
5 explained for preferred embodiments with reference to  
the drawings.

[ FIRST EMBODIMENT]

Figure 1A is a plan view diagram showing a  
10 printed circuit board 40 according to a first  
embodiment of the present invention in the state of  
carrying an electronic component thereon while Figure  
1B is a cross-sectional diagram taken along an A-A  
line in Figure 1A.

15 Referring to Figures 1A and 1B, the printed  
circuit board 40 comprises an insulating base  
substrate 1 carrying a metal film such as a copper  
film on the surface thereof, wherein the metal film  
thus formed is patterned to form a circuit pattern  
20 not illustrated and a land 2 connected to the circuit  
pattern.

Further, the printed circuit board 40  
carries an electronic component 10, which may be a  
charging control circuit of a secondary battery  
25 configured in the form of integrated circuit or a

passive component, wherein the electronic component 4 is connected to the foregoing circuit pattern formed on the base substrate 1. It should be noted that the land 2 is formed in electrical connection with the circuit pattern formed in the region on which the electronic component 10 is mounted.

It will be noted that the land 2 is formed with through-holes 6 such that the through-holes 6 are provided with metal plating at the inner wall surface thereof. In the case the printed circuit board 40 is a two-sided substrate, there are formed a land and a circuit pattern also on a rear surface of the base substrate 1, wherein the through-hole provides an electrical interconnection between the front side land and the rear side land or between the front side circuit pattern and the rear side circuit pattern.

Further, in the case the printed circuit substrate 40 is a multilayer interconnection substrate, there are formed also internal circuit patterns embedded inside the base substrate. Thereby, the through-hole 6 provides an electrical interconnection between these internal circuit patterns or between one of the internal circuit patterns and the land or interconnection pattern at

the front surface or rear surface of the base substrate 1.

In the present embodiment, the through-hole 6 is filled with a solder alloy, wherein the solder alloy thus filling the through-hole provides a mechanical connection between the land 2 and the base substrate 1. In the case of the multilayer interconnection structure, the solder alloy thus filling the through-hole provides also an electrical connection interconnection between the internal circuit patterns. Thus, with the printed circuit board of the present embodiment, the land 2 is mechanically connected to the base substrate 1 via the solder alloy in the through hole 6, and with this, the resistance of the land 2 from being pulled off from the base 1 is increased significantly.

With the embodiment of Figure 1, it should further be noted that there is formed a second land at the rear surface of the base substrate 1 so as to oppose the land 2, wherein electrical as well as mechanical connection is achieved between the land 2 and the land 7 via the solder alloy filling the through-hole 6. With such a structure, the land 2 is not only connected to the base substrate 1 via the solder alloy in the through-hole 6 but also to the

land 7 at the rear side, and thus, the resistance of the land 2 from being pulled off from the substrate 1 is increased further.

Figure 2 is shows the printed circuit board  
5 40 of the present embodiment in the state that a metal plate is provided on the land 2 as an external interconnection terminal.

Referring to Figure 2, the metal plate 4 is formed to have an area larger than the area of the  
10 land 2 in anticipation of spot welding conducted for interconnection with external electronic apparatuses, wherein the metal plate 4 is soldered upon the land 2 via a solder layer 5 with alignment such that the plate 4 covers the entirety of the land 2. In the  
15 case that the electronic apparatus used with the printed circuit board is a secondary battery, it is preferable that a nickel plate is used for the metal plate 4 in anticipation with spot welding thereto.

In the example of Figure 2, the external  
20 interconnection terminal is formed by connecting the metal plate 4 to the land 2 and the land 7 is provided at the rear side of the substrate 1. However, it should be noted that the present invention also includes a printed circuit board in  
25 which the land 7 is not provided on the rear side of

the base substrate 1.

Further, such a construction facilitates dissipation of heat at the time of spot welding of electrode of external electronic apparatus such as the secondary battery to the metal plate 4. Thus, the heat at the time of the spot welding dissipates efficiently to the substrate via the through-hole 6, and with this, scattering of the molten solder 5 is effectively prevented.

10 In order to solder the metal plate 4 to the land 2 by filling the solder alloy in the through-hole 6, a solder paste is applied on the surface of the land 2 and the metal plate 4 is placed on the land 2. Then, the printed circuit board 1 is caused to pass through a reflow furnace, wherein the solder paste undergoes melting and the solder alloy layer 5 is formed so as to connect the metal plate 4 to the land 2. At the time of such a reflowing process caused in the reflowing furnace, the molten solder alloy flows also into the through-hole 6, and the land 2 is firmly connected mechanically also to the base substrate 1 and to the second land 7.

While there are formed four through-holes in the examples of Figures 1 and 2, the number of the through-holes 6 is by no means limited to four but

can be increased or decreased according to the size of the land 2. Further, the through-holes 6 may be formed with an optimum arrangement determined in view of the size of the land 2 and in consideration of the  
5 locations where the mechanical stress acting on the interconnection terminal for pulling off the metal plate 4 becomes the largest.

[ SECOND EMBODIMENT]

10                Figures 3A and 3B show a printed circuit board 50 according to a second embodiment of the present invention, wherein those parts corresponding to the parts described previously are designated by the same reference numerals and the description  
15 thereof will be omitted.

Referring to Figures 3A and 3B, it can be seen that there is provided a solder resist layer on the structure of Figures 1A and 1B such that the solder resist layer 3 extends continuously from the  
20 peripheral edge part of the land 2 to the part of the base substrate 1 surrounding the land 2.

By covering the peripheral edge of the land 2 with the solder resist layer 3, the mechanical stability of the land 2 resisting from being pulled  
25 off from the base substrate 1 is improved further.



Figure 4 shows the printed circuit board 50 of the third embodiment in the state that the metal plate 4 is soldered upon the land 2 of the printed circuit board 50 by way of the solder alloy layer 5.

5 By reinforcing the land 2 with the solder alloy filling the through-holes 6 and further with the solder resist layer 3 with the printed circuit board 50 of the present invention, it becomes possible that to prevent the external interconnection  
10 terminals from being pulled off from the base substrate 1 even in the case a large stress is applied to the metal plate 4. Further, such a solder resist layer 3 functions to prevent scattering of the molten alloy in the event of carrying out a spot  
15 welding of an electrode of the electronic apparatus such as a secondary battery to the metal plate 4.

In Figures 3 and 4, in which there is formed a second land 7 at the rear side of the base substrate 1 and the land 2 and the land 7 are  
20 connected by the solder alloy in the through-hole 6, the resistance of the land 2 from being pulled off from the base substrate 1 is improved further as compared with the case in which the land 7 is not provided on the rear side of the base substrate 1.  
25 However, the present embodiment also covers such a

construction in which the land 7 is not provided on the rear side of the base substrate 1.

It should be noted that a solder resist is an insulation film used for protecting a circuit pattern when soldering an electronic component mounted on a substrate, and is typically formed of a heat resistant resin such as epoxy resin. The present embodiment can also use such a conventional solder resist for the solder resist layer 3.

10           The solder resist layer 3 may be formed by a process of applying a solder resist on the entire surface of the printed circuit board and then form a resist pattern on the part where the solder resist layer should be retained. Thereby, the solder resist layer is patterned by an etching process while using the resist pattern as a mask. Alternatively, it is possible to form a solder resist layer selectively by a screen printing process, or the like.

Further, it is possible to use a photosensitive solder resist for the solder resist layer 3. For example, it is possible to use a UV-cure solder resist material, which is a solder resist material undergoing curing with ultraviolet radiation. In the case of using a UV-cure solder resist, the part of the solder resist layer to be

removed is covered by a UV-cut mask, and UV  
irradiation is applied via the UV-cut mask. Thereby,  
the part of the solder resist layer not covered with  
the mask undergoes curing, and the uncured part of  
5 the resist layer is removed by a developing solution.  
Further, the remaining solder resist pattern is  
applied with thermal curing process.

[ THIRD EMBODIMENT]

10                Figures 5 through 8 show examples of the  
land 2 according to a third embodiment of the present  
invention in which various solder resist patterns are  
formed on the land 2. It should be noted that each  
example described hereinafter covers the case in  
15 which the land 7 is provided on the rear side of the  
base substrate 1 and the case in which such a land 7  
is not provided.

                 In the example of Figure 5 showing a  
printed circuit board 60A, there is formed a solder  
20 resist layer 12a in the form of a frame pattern  
extending along the peripheral edge of the land 2.  
Contrary to the solder resist layer 3 of the  
embodiment of Figures 3A and 3B in which the solder  
resist layer 3 extends continuously from the  
25 peripheral edge part of the land 2 to the part of the

base substrate 1 surrounding the land 2, the solder resist pattern 12A is formed exclusively inside the area of the land 2.

Further, in the illustrated example, there  
5 are formed plural thorough-holes 6 in the land 2. While the positional relationship of the through-holes 6 and the solder resist layer 12a is not limited, the example of FIG.5 disposes the through-holes along the outer edge of the frame-like solder  
10 resist pattern 12a.

By forming the through-holes 6 and the solder resist pattern 12a as such, not only the bonding strength of the land 2 to the base substrate 1 of the printed circuit board 60A is improved but  
15 also the efficiency of dissipation of the heat at the time of spot welding of the metal plate. The heat dissipates to the base substrate 1 via the through-holes 6. Thereby, the molten solder alloy is held by the solder resist layer 12a, and thus, scattering of  
20 the molten solder alloy to the outside is effectively prevented as long as the spot welding is conducted inside the frame structure of the solder resist pattern 12a. Further, because of formation of the fillet at the peripheral edge of the land 2, the  
25 effective soldering area is increased and the bonding

strength of the metal plate 4 is increased further.

In the example of Figure 6 showing a printed circuit board 60B, there is provided a T-shaped solder resist pattern 12b on the land 2. In  
5 this example, too, it can be seen that there are provided plural through-holes 6. While the positional relationship between the through-holes 6 and the solder resist pattern 12b is not limited, the illustrated example has a construction of disposing  
10 the through-holes 6 inside the vertical part of the T-shaped solder resist pattern 12b.

By forming the through-holes 6 and the solder resist pattern 12b of T-shaped form as such, not only the bonding strength of the land 2 and the  
15 base substrate 1 of the printed circuit board is improved by way of the through-holes 6 but also the efficiency of heat dissipation at the time of spot welding of a metal plate upon the metal plate 4 soldered to the land 2. The heat dissipates to the  
20 base substrate 1 via the through holes 6. Thereby, the molten solder alloy is held by the solder resist layer 12a, and thus, scattering of the molten solder alloy to the outside in the right direction of the vertical solder resist pattern 12b is effectively  
25 prevented as long as the spot welding is conducted at

the left side of the solder resist pattern 12b.

Further, with the embodiment of Figure 6, the majority of the area of the land 2 is divided symmetrically into a part 2a and a part 2b with the  
5 horizontal part of the T-shaped solder resist pattern 12b. Thus, drifting of the metal plate 4 at the time of soldering upon the land 2 is effectively suppressed, and the metal plate 4 can be provided with high precision.

10 Further, because the land 2 is divided by the solder resist pattern 12b, which extends from inside of the area of the land 2 to the outside thereof, formation of pores between the land 2 and the metal plate 4 is suppressed when the metal plate  
15 4 is soldered upon the land 2. Thereby, substantial area of soldering is increased, and the bonding strength of the metal plate 4 to the land 2 is improved.

In the example of Figure 7 showing a  
20 printed circuit board 60C, there is provided an H-shaped solder resist pattern 12c on the land 2. In this example, too, it can be seen that there are provided plural through-holes 6. While the positional relationship between the through-holes 6 and the  
25 solder resist pattern 12c is not limited, the

illustrated example has a construction of disposing the through-holes 6 inside the vertical parts of the H-shaped solder resist pattern 12c.

By forming the through-holes 6 and the  
5 solder resist pattern 12c of H-shaped form as such, not only the bonding strength of the land 2 and the base substrate 1 of the printed circuit board is improved by way of the through-holes 6 but also the efficiency of heat dissipation at the time of spot  
10 welding of a metal plate upon the metal plate 4 soldered to the land 2. The heat dissipates to the base substrate 1 via the through holes 6. Thereby, the molten solder alloy is held by the solder resist layer 12c, and thus, scattering of the molten solder  
15 alloy to the outside in the right and left directions of the vertical pattern parts of the H-shaped solder resist pattern 12c is effectively prevented as long as the spot welding is conducted inside of the two vertical patterns of the H-shaped solder resist  
20 pattern 12c.

Further, with the embodiment of Figure 7, too, the majority of the area of the land 2 is divided symmetrically into plural parts by the H-shaped solder resist pattern 12c. Thus, drifting of  
25 the metal plate 4 at the time of soldering upon the

land 2 is effectively suppressed, and the metal plate 4 can be provided with high precision.

Further, because the land 2 is divided by the solder resist pattern 12c, which extends from  
5 inside of the area of the land 2 to the outside thereof, formation of pores between the land 2 and the metal plate 4 is suppressed when the metal plate 4 is soldered upon the land 2. Thereby, substantial area of soldering is increased, and the bonding  
10 strength of the metal plate 4 to the land 2 is improved.

In the example of Figure 8 showing a printed circuit board 60D, there is provided a frame-like solder resist pattern 12d on the land 2 having a  
15 horizontal pattern part extending laterally and dividing the area of the land 2 symmetrically into upper and lower parts. In this example, too, it can be seen that there are provided plural through-holes 6. While the positional relationship between the  
20 through-holes 6 and the solder resist pattern 12d is not limited, the illustrated example has a construction of disposing the through-holes 6 along the frame-shaped part of the solder resist pattern 12d at the outside thereof.

25 By forming the through-holes 6 and the



solder resist pattern 12d of symmetric form as such,  
not only the bonding strength of the land 2 and the  
base substrate 1 of the printed circuit board is  
improved by way of the through-holes 6 but also the  
5 efficiency of heat dissipation at the time of spot  
welding of a metal plate upon the metal plate 4  
soldered to the land 2. The heat dissipates to the  
base substrate 1 via the through holes 6. Thereby,  
the molten solder alloy is held by the solder resist  
10 layer 12d, and thus, scattering of the molten solder  
alloy to the outside of the frame-like solder resist  
pattern 12d is effectively prevented as long as the  
spot welding is conducted inside the framework of the  
solder resist pattern 12d.

15 Further, with the embodiment of Figure 8,  
too, the majority of the area of the land 2 is  
divided symmetrically into plural parts by the solder  
resist pattern 12d. Thus, drifting of the metal plate  
4 at the time of soldering upon the land 2 is  
20 effectively suppressed, and the metal plate 4 can be  
provided with high precision.

Further, because the land 2 is divided by  
the solder resist pattern 12d, which extends from  
inside of the area of the land 2 to the outside  
25 thereof, formation of pores between the land 2 and

the metal plate 4 is suppressed when the metal plate 4 is soldered upon the land 2. Thereby, substantial area of soldering is increased, and the bonding strength of the metal plate 4 to the land 2 is  
5 improved.

[ FOURTH EMBODIMENT]

Figure 9A shows the construction of a printed circuit board 70 according to a fourth  
10 embodiment of the present invention in a plan view while Figure 9B shows the printed circuit board 70 in a cross-sectional view taken along a line A-A of Figure 9A, wherein those parts corresponding to the parts described previously are designated by the same  
15 reference numerals and the description thereof will be omitted.

Referring to Figures 9A and 9B, it can be seen that there is provided no through-holes 6 and that no land is provided at the rear side of the base  
20 substrate 1.

On the other hand, the present embodiment provides a solder resist layer 3 for increasing the resistance of the land 2 from being pulled off from the base substrate 1, such that the solder resist  
25 layer 3 extends continuously from the peripheral edge

part of the land to the part of the surface of the base substrate 1 surrounding the land 2.

Thus, by covering the peripheral edge of the land 2 with the solder resist layer 3, the resistance of the land 2 from being pulled off from the printed circuit board 1 is improved further.

[ FIFTH EMBODIMENT]

Figure 10A shows the construction of a printed circuit board 80 according to a fifth embodiment of the present invention in a plan view while Figure 10B shows the printed circuit board 80 in a cross-sectional view taken along a line A-A of Figure 10A, wherein those parts corresponding to the parts described previously are designated by the same reference numerals and the description thereof will be omitted.

Referring to Figures 10A and 10B, it can be seen that the printed circuit board 80 has a construction in which the metal plate 4 is soldered upon the land 2 of the printed circuit board 70 of Figures 9A and 9B.

Because the land 2 is reinforced by the solder resist layer 3 as explained with reference to Figures 9A and 9B, peeling off or dropping of the

external interconnection terminal from the printed circuit board 1 is effectively prevented even when a large force is exerted to the metal plate 4 as in the case of spot welding of an electrode of an external  
5 electronic apparatus such as a secondary battery to the metal plate 4. Further, because of the existence of the solder resist layer 3, scattering of the molten resist is prevented by the solder resist layer 3 at the time of spot welding of an electrode of  
10 external electronic apparatus such as a secondary battery to the metal plate 4.

[ SIXTH EMBODIMENT]

Figure 11A shows the construction of a  
15 printed circuit board 90 according to a sixth embodiment of the present invention in a plan view while Figure 11B shows the printed circuit board 90 in a cross-sectional view taken along a line A-A of Figure 11A, wherein those parts corresponding to the  
20 parts described previously are designated by the same reference numerals and the description thereof will be omitted.

Referring to Figures 11A and 11B, it can be seen that the printed circuit board 90 has a  
25 construction similar to that of the printed circuit

board 70 of Figures 9A and 9B in that the solder resist layer 3 is provided for the purpose of increasing resistance of the land 2 from being pulled off from the base substrate 1, such that the solder resist layer 3 extends continuously from the peripheral edge part of the land to the part of the surface of the base substrate 1 surrounding the land 2. Further, with the present embodiment, there is formed a solder resist pattern 14 on the land 2 in continuation with the solder resist layer 3 at the peripheral edge of the land 2 so as to divide the area of the land 2 into two regions.

With the present embodiment, the solder resist layer 3 functions similarly to the embodiment of Figures 9A and 9B.

Further, the solder resist pattern 14 dividing the exposed area of the land 2 into two sub-regions facilitates elimination of pores at the time of soldering the metal plate 4 to the land 2 by causing the printed circuit board 90 to pass through a reflowing furnace in the state that the metal 4 is placed on the land 2. Thereby, effective soldering area of the metal plate 4 to the land 2 is increased and the bonding strength of the metal plate 4 to the land 2 is improved.

While the embodiment of Figure 11 divides the exposed part of the land 2 into two sub-regions by the solder resist layer 3 and the solder resist pattern 14, the number of division of the land area is not limited to two, and the solder resist layer 3 and the solder resist pattern 14 can be optimized with regard to the number of the sub-regions formed as a result of the division or the shape of the sub-regions according to the size of the land 2.

10

[ SEVENTH EMBODIMENT]

Figure 12A shows the construction of a printed circuit board 100 according to a seventh embodiment of the present invention in a plan view while Figure 12B shows the printed circuit board 100 in a cross-sectional view taken along a line A-A of Figure 12A, wherein those parts corresponding to the parts described previously are designated by the same reference numerals and the description thereof will be omitted.

Referring to Figures 12A and 12B, the printed circuit board 100 has a construction of the printed circuit board 80 of Figures 10A and 10B except that a metal plate 8, which may be the member connected to the electrode of an external apparatus

25

such as a secondary battery, is connected to the metal plate 4 by way of spot welding.

Thus, the metal plate 8 is laid on the metal plate 4, and spot welding is conducted at four  
5 locations 9 in this state. However, the number of the locations 9 of the spot welding is not limited to four but can be increased or decreased according to the size of the metal plate 4. Further, the location  
9 of the spot welding can be optimized in  
10 consideration of the part of where the external force acting to pull out the external interconnection terminal becomes maximum at the time of the spot welding.

Further, while Figures 12A and 12B show the  
15 case of spot-welding the second metal plate 8 to the metal plate 4 constituting the external interconnection terminal of the printed circuit board 80 of Figures 10A and 10B, such spot welding can be conducted in the printed circuit board of other  
20 embodiments.

In one important application of the present invention, the metal plate 8 constitutes a part of the metal plate having an end spot-welded to an electrode of a battery pack, or the like. In such a  
25 case, it is preferable to form both the metal plate 4

and the metal plate 8 by nickel or an alloy containing nickel as a primary component.

[ EIGHTH EMBODIMENT]

5                   Figure 13 is a diagram showing the construction of an electronic apparatus 110 that includes a printed circuit assembly carrying an electronic component on a printed circuit board according to an eight embodiment of the present  
10 invention, wherein those parts corresponding to the parts explained previously are designated by the same reference numerals and the description thereof will be omitted.

Referring to Figure 13, the electronic  
15 apparatus 110 is a secondary battery pack including therein a secondary battery 24 used with portable apparatuses such as a cellular phone, wherein the secondary battery pack 110 further includes a printed circuit assembly 20 including a charging control  
20 circuit of the secondary battery 24 in the form of a semiconductor integrated circuit mounted upon the base substrate 1 of any of the printed circuit boards of the preceding embodiments as an electronic component 10. It should be noted that the electronic  
25 component 10 is sealed by a resin such as an epoxy



resin.

In the construction of Figure 13, a nickel plate is used for the metal plate 4 forming the external interconnection terminal in the printed circuit assembly 20, wherein the metal plate 8 connected to the electrode of the secondary battery 24 is formed also of a nickel plate. Thereby, the metal plate 4 and the metal plate 8 are connected with each other by spot welding as explained with reference to Figures 12A and 12B.

According to the printed circuit board of the present invention, the resistance of the external interconnection terminal thereof from being pulled off is increased, and thus, the printed circuit board is suitable for use with compact portable apparatuses.

Further, the present invention is by no means limited to the embodiments described heretofore, but various variations and modifications may be made without departing from the scope of the invention.